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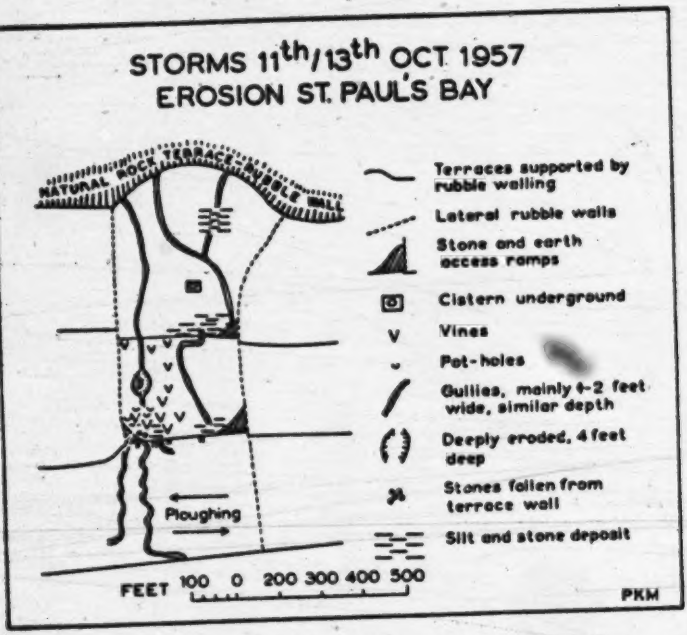

Fig. 17 Storms of 11th/13th Oct. 1957, Erosion, St. Paul's Bay.

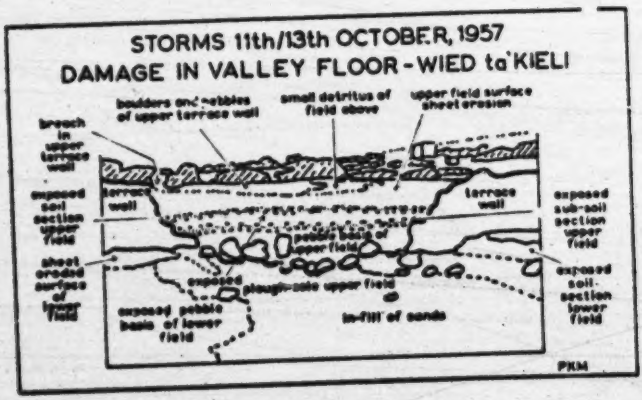

Fig. 18 Storms of 11th/13th Oct. 1957, Damage in Valley Floor, Wied ta' Kieli.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

The figures show that annual P.E. exceeds annual precipitation by nearly 100 per cent., a moisture surplus of 7.5 inches for the months of October to February inclusive being more than offset by a moisture deficiency of 19.6 inches, almost as great as the average rainfall, in the remaining seven months of the year. In practical terms this means that the maintenance of a herbaceous vegetation cover throughout the year would require a water supply equivalent to 40.1 inches of rainfall distributed according to the monthly P.E. values. Rainfall itself supplies only half this amount and the remainder must come from other sources as, for example, when irrigation is applied. In the latter case, water is brought in from elsewhere, during the limited growing season of cultivated plants, to supplement the supply from precipitation. However, the position is less simple than suggested by the foregoing statement. Application of water at the required rate can damage the soil by preventing proper aeration and may also cause disease in the growing crop. On the other hand, if the total amount of water supplied to a crop falls below the cumulative P.E. rate of the growing season by more than an inch or two, then full growth of the plant is prevented. Furthermore, surplus moisture will be stored in the soil from the wetter months to augment the supply in months of rainfall deficiency, the extent to which this takes place being dependent on such factors as type and depth of soil and the nature of the crop itself. Thornethwaite (41) has shown that, in humid areas, the majority of crops can only abstract 4 inches of water from the soil in this way but such a generalisation cannot apply to many of Malta's extremely thin soils, which are physically incapable of retaining so much water. The moisture-holding capacity of the soil is also significant in relation to run-off which will only occur once that capacity has been exceeded.

There are as yet, no data on the moisture-holding capacity of Maltese soils. In the computations which follow (Table 20), three values have been assumed - 2½ inches, 4 inches and 6 inches - of which the intermediate is the most likely average. These fuller figures give a truer picture of the water balance than that available from the moisture surplus and deficiency data of Table 19.

It will be observed that the whole moisture surplus of October and November is absorbed in soil moisture recharge, that is in the replacement of moisture removed from the soil during the dry summer months and that it is not until December that an actual water surplus occurs and that there are, in fact, only three months with such a surplus (two in soils with 6 inches storage capacity), which will be expressed in direct run-off and in percolation into the water table.

On the assumption made in the computation of Table 20 that evapo-transpiration will take place at the full potential rate so long as there is any moisture stored in the soil it will be seen that the length of the growing season depends on soil moisture storage capacity. Thus, at the 2½ inches level, full plant growth is possible from October to early May (Fig. 23), at the 4 inches level, the season is extended by some two weeks and, at the 6 inches level, it would continue into early June. Water surplus also varies with soil character; so does the date at which significant run-off begins.

If the average soil moisture storage capacity is assumed to be 4 inches, December-February water surplus is seen to be 3.5 inches. Since this is based on the Valletta rainfall data it would be wise to raise this figure to 4.2 inches for the Islands as a whole (see p 75). Making the further (erroneous) assumption that the land surface is completely covered with soil, the total available water, including both percolation and run-off, would be some 7,000 million gallons. We have already seen (p. 45) that some 2,000 million gallons are used for irrigation and a further 2,400 million in the public water supply. If it is further recalled that a good deal of the precipitation is lost by direct run-off or by sub-surface percolation into the sea (p. 43) it will be realised that the 'water balance' is in fact in a precarious state of unbalance.

There are several implications here for the agriculturalist. In the first place, there is little prospect of obtaining additional water for irrigation purposes in years of average rainfall. Secondly, it is essential that excessive amounts of irrigation water should never be applied. Some indication of irrigation requirements may be obtained from P.E. data and an attempt has been made (Fig. 24)

Table 20. Water balance - Malta. Inches.
Assuming soil storage capacities of 2½ inches, 4 inches and 6 inches.

	A	S	O	N	D	J	F	M	A	M	J	J	Yr.
Moisture surplus			0.1	1.8	3.4	2.2	1.0						
Moisture deficiency	6.5	3.7						0.3	1.6	3.4	6.0	6.7	19.6
Soil storage capacity 2½ inches													
Soil m. recharge			0.1	1.8	0.6								2.5
Water surplus					1.8	2.2	1.0						5.0
Soil m. utilisation								0.3	1.6	0.6			2.5
Deficiency	6.5	3.7								3.8	5.0	6.7	
Soil moisture deficit	2.5	2.5	2.4	0.6	0	0	0	0.3	1.6	2.5	2.5	2.5	
Soil storage capacity 4 inches													
S.M.R.			0.1	1.8	2.1								4.0
W.S.					0.3	2.2	1.0						3.5
S.M.U.								0.3	1.6	2.1			4.0
D	6.5	3.7								1.3	5.0	6.7	
S.M.D.	4.0	4.0	3.9	2.1	0	0	0	0.3	1.9	4.0	4.0	4.0	
Soil storage capacity 6 inches													
S.M.R.			0.1	1.8	2.4	1.7							6.0
W.S.						0.5	1.0						1.5
S.M.U.								0.3	1.6	3.4	0.7		6.0
D	6.5	3.7									4.3	6.7	
S.M.D.	6.0	6.0	5.9	4.1	1.7	0	0	0.3	1.9	5.3	6.0	6.0	

to prepare an irrigation schedule on the basis of the figures discussed in this chapter. The schedule is for a field in which potatoes, sown in September, are followed by further potato plantings in January and by the setting-out of tomatoes in late April. Regular P.E., rainfall and irrigation are assumed and soil moisture deficit of 2 inches at the end of each crop's growth is permitted (a figure allowed for shallow-rooted crops in U.K. Ministry of Agriculture experiments). The schedule indicates a maximum irrigation of 3.2 inches in the week of planting first-crop potatoes (when soil moisture deficit must be restored) and a similar amount is applied to the young tomatoes. The potatoes require less irrigation in subsequent weeks when soil moisture is near capacity and rainfall is increasing while P.E. is falling. A total of 5.4 inches of irrigation is required by this crop. Winter-sown potatoes need no irrigation but they deplete soil moisture reserves which must be restored when tomatoes are planted. During the growing season of the latter crop, soil moisture is allowed to decline but P.E. is increasing and irrigation rates rise from 0.8 inch per week in early May to 1.5 inches in July, the latter being equivalent to 9,450 gallons per tomna. The tomato crop requires a total of 22 inches.

It must be emphasised that this schedule is based on average conditions and on an even distribution of rainfall within each month, conditions which rarely, if ever, occur. The method, however, might be more profitably applied on the basis of P.E. rates, rainfall and precise planting dates in particular seasons. When more information on P.E. rates in Malta becomes available, experiments in the application of the water balance technique to the problem of irrigation might well show a profit in a more efficient use of water supplies.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

[P.83]

Chapter III

EDAPHIC AND ECOLOGICAL

A. Soils of Malta and Gozo (Fig. 27)

* D. M. LANG, Ph.D.

FACTORS OF SOIL DEVELOPMENT IN THE MALTESE ISLANDS

Soil is a commonplace which everyone recognises but few would attempt to define or even describe. Joffe (1949) defines soil as 'a natural body of mineral and organic constituents usually unconsolidated, differentiated into horizons, of variable depth, which differs from the material below in morphology, physical make-up, chemical properties and composition and biological characteristics'. This definition, like many others, does not satisfy everyone. It does not emphasise, for example, that the soil is continually changing because the plants which grow in it and the active myriads of the soil microfauna whose home it is, cause changes in its characteristics. However, to include this and many other concepts which it might be desirable to use would require a long time and a lot of paper, because soil is essentially very complex.

There are, according to Dokuchaeff, five factors involved in the development of soil, and of these probably three, parent material, climate and time, are fundamental in the production of the soils of Malta. Topography, the fourth factor, is largely dependent on the first three, since landscape is largely moulded by erosion and deposition related to the parent structure, process and time. Biological influences, the fifth factor, despite the activity of plants and animals, is presently dominated by man's work, the effects of which are secondary, producing modifications of the existing patterns, but nonetheless sometimes profound.

TIME

Maltese soils are all rather young or immature since pedological processes are slow in calcareous soils like these, particularly where acidic drainage water is very limited in quantity. Certain soils, for example, the red brown clays of the Terra group (p. 92) are believed to have formed largely under the influence of processes which have been superseded. Under a changed climate the new very slow processes have so far produced little change in the soil profile. It is a relic of the old process and thus the soils are, in a sense, relic soils, but at the same time very immature (young) soils under the new climate, because the new process has produced so little change.

In the San Biagio series, very young, man-made, carbonate raw soils (p. 87) dating only from when they were mined from the rock, are found in front of undermined terrace backwalls. Only a few yards away much older soils are developed from the same parent rock, and they are xerorendzinas (p. 90). While the raw soil has been subjected to natural processes for less than 50 years, the xerorendzina has been developing over several hundred years. Thus time is an important factor in the soil's development.

CLIMATE

The climate of Malta and Gozo, is a good example of the Mediterranean type. It consists of hot dry summers, having a high rate of evaporation and no rain, warm and showery autumns normally with a rainfall deficit, short cool winters with enough rainfall for agriculture in most years, but leaving insufficient reserve in the soil to combat the warm drying springs again having a rainfall deficit. The variation on sites of the same type is obviously small, but between deep-set valleys, north-facing scarp slopes and the main open plateaux or south-facing slopes there are often wellmarked differences in vegetation, both weeds and crops. The difference is striking because of the difference in insolation, and

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1: Bowen-Jones et al. K-5 (1955-1958) 1961
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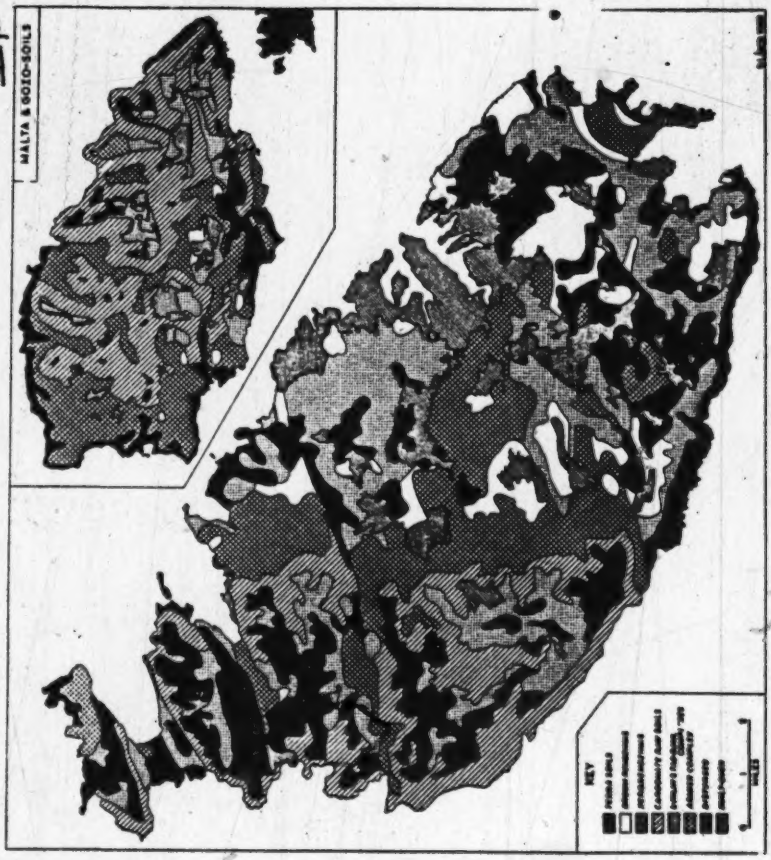

Fig. 37 Soils of Malta and Gozo.

thus of surface temperature regime. However, soil profiles show virtually no difference between different sites, and it is only in exceptionally wet locations that the normal pattern of aridity is sufficiently overcome to allow the development of noticeable humus horizons. 132 134

In the past there have been broad oscillations of climate responsible for the production at different times of widely differing soil materials such as the 'red soil' (red brown Terra clays), stoney calcareous debris and aeolian sands which are now the materials parent to the present soil. The present climate, however, is not a leaching climate.

This uniformly arid climate is in strong contrast with that of some other latitudes, for example, that of Britain, and suggests itself as the reason for the restricted range of soils found in Malta and Gozo.

PARENT MATERIAL

The rocks which are ancestors to the soils are all closely similar in type chemically, and only moderately variable in physical characteristics. Thus only a limited range of soil types is to be expected. However, the massive, well-jointed limestones have developed karst landscapes because they favour percolation and solution more than do the porous but nearly impervious finer-textured limestones. On the karstlands the red brown Terra clays have developed on almost completely de-calcified residues from the limestone, but on the other landscapes there has been a minimum of decalcification, and the soils are very like the rocks from which they have been formed. Thus, the composition of the impurities in the limestones from which they were originally weathered mainly decides the nature of the Terra soils (although inblown calcite has increased their calcium carbonate content). Similarly the texture and detailed composition of the carbonate raw soils and xerorendzinas is closely dependent on the parent material. The parent material type is therefore important for Maltese soils because it partly determines what pedological processes can take place and especially because the processes taking place now have little effect. 133 134

TOPOGRAPHY

Topography generally influences the development of the soil in a variety of ways, and chiefly through modifications of climate, variable conditions of drainage and effects on erosion and transportation processes. It has been noted that in Malta and Gozo the variations of topography produce sites with very different insolation conditions, but the effect on soil processes is negligible. It is only in the extremely freely-drained conditions of some hill tops, where lime crust yermas are simulated on parent materials of fine sandy loam texture that the effect of topography on drainage conditions can be thought to be sufficient to produce soil modifications. Flooding with sea water may be attributed to topography, and in the Alcol series at Salinas, for example, slight salinity is the result.

The effect of topography on erosion, transportation and deposition is more noticeable. Under former cooler climatic conditions, solifluction took place, and under the present conditions sheet or gully erosion occurs during the violent showers of late autumn. The result is that there are strikingly different eroded and alluvial phases of the same soil series in some locations. On the Blue Clay soils the alluvial, light clay type is more favourable to agriculture than the eroded heavy clay type which is in patches alkaline or saline-alkaline.

BIOLOGICAL INFLUENCES

Apart from man's activities, biotic factors are of relatively small importance in the soils. Humus horizons are only developed under well grown and long undisturbed vegetation, which is very rare. The organic-matter deficient humus forms of the surface horizons of the cultivated soils can only be seen easily under the microscope, and the soil fauna seems to be very limited in numbers. 134 311

The modifications of the soil pattern produced by man are, on the other hand most profound. Apart from the large area of Malta which has been covered by human habitations, factories, airfields and military installations, where the

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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soil has been bulldozed or covered up and is unrecognisable, the pattern of soils in the agricultural land has been changed.

Firstly, nearly all the land in Gozo and most of the land in Malta has been terraced, on slopes so steep that the terraces must be very narrow, with very high retaining walls. The backwalls of the terrace are often cut into the solid rock and the resulting rockflour mixed with the soil material, while the floor of the terrace is quarried and made flat and then covered with rubble before the soil material is replaced on it.

Terracing of this type is very widespread on the cultivated areas except on alluvial parent materials, and gives rise in the karst lands to a complex of soils described as 1-Iklin complex, ranging from carbonate raw soils to Terra-like soils, dependent on the amount of rockflour and rubble added to the original Terra soils during terracing.

Where quarries have been dug, the soil has been replaced in a similar way, with added rubble, refuse and rockflour in terraces which have been built up at several levels in the quarry. The resultant mixed soils have been referred to as tad-Dawl complex, which is rather similar to 1-Iklin.

The use of inorganic town refuse on the soils and the large-scale carting of soil material away from building sites to wherever it may be desired adds to the generally rather confused nature of many of the soils, and since about 0,1 per cent. of the total soil cover is moved every three years in this way, the scale is quite large.

To summarise, the pattern which man modified was dependent mainly on parent material, time and the ineffectiveness of the climate in producing soil horison development. The effects of utilisation by man have produced widespread and profound modifications of that pattern.

Table 21. Classification of the soils of Malta and Gozo according to the system of Kubiena (1953).

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Division	Class	Type	Sub-type	Variety	Series
A. Sub-aqueous					
B. Semi-terrestrial	BD Salt soils		Secondary salt soils		
C. Terrestrial	CA Terrestrial raw soils	Syrosem	Carbonate Syrosem (Carbonate Raw Soil)		Fiddien Nadur Ramla San Lawrens
	CB Not represented in Malta				
	CC Rendzina-like soils	Rendzina	Xerorendzina		Alcol San Biagio tal-Barrani
	CD Not represented in Malta				
	CE Terrae Calcis	Terra	Terra fusca	Earthy terra fusca	tas-Sigra
			Terra rossa	Biallitic terra rossa	Xaghra
	CF CG CH CI CJ	Not represented in Malta			

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The table (21) which is based on Kubiena's classification illustrates the small range of soils found in Malta and Gozo. There are no sub-aqueous soils, and only a small fraction of one per cent. of the soils are secondarily saline and thus classified as semi-terrestial, although some of the present soils (for example, Alcol) are developed on alluvial (semi-terrestrial) soils, from an earlier climatic era.

In the account following we describe first the carbonate raw soils, which are only slightly differentiated from their parent material and then the xerorendzinas in which the humus development becomes apparent. The San Biagio soils are typical xerorendzinas but the Alcol and tal-Barrani series contain sufficient brown sesquioxide clay material to give the soils deeper brown colours than are usual. In the former case this is because of the red-brown clays in the sediments on which the soils are developed, and in the latter case partly for similar reasons and partly because of slight accumulation of precipitated iron. Finally, we consider the reddish-brown Terra soils in which limestone weathering has progressed so far as to leave largely decalcified residues of limestone as the mineral body of the soil. The writer inclines to the view that the removal of calcium carbonate in both the last mentioned soils occurred under moister conditions than now obtain, a view with which some authorities are not entirely in agreement.

CARBONATE RAW SOILS

According to Kubiena (1953) the carbonate raw soil is a 'very young raw soil, extremely low in humus, characterised generally by a dry summer (on the surface partly also hot summer) soil climate on calcareous parent rocks'.

These soils have an (A) C profile, that is to say an (A) horizon overlies the C or parent material horizon. The (A) horizon is the zone most strongly colonised by organisms, the well aerated superficial layer of soils in which no recognisable humus horizons have developed. It has a recognisable humus form, raw soil humus consisting of a few fragments of undecomposed plant remains in some of which there are cavities containing droppings of mining animals; the mineral grains are calcite. Usually only the calcite sand will be obvious to the unaided eye.

Occasionally the (A) horizon will overlie a Ca horizon of secondary calcium carbonate precipitation above the C horizon.

In Malta and Gozo four series of carbonate raw soil have been distinguished, on the basis of variation in the parent material to which the biological soil is so closely related. These are the Nadur, Ramla, Fiddien and San Lawrenz series. The organic matter content is very low and only in one surface sample of 13 profiles sampled was as much as 2 per cent. found, while in most cases there was only 1-1½ per cent. Lower horizons generally showed less than 1 per cent. organic matter. At the same time the calcium carbonate content was high, about 80-90 per cent. in soils derived from the soft limestones and 30-60 per cent. in those derived from the Blue Clay.

NADUR

Parent material and location: The Nadur series is mainly developed from weathered calcareous sandstones of Quaternary age and similar materials from the lower part of the Upper Coralline Limestone, and the Greensand formation, mixed with downwashed red clay material of the Xaghra soil from the Middle Upper Coralline Limestone. The Nadur soil is usually developed as a narrow belt along the upper slopes of the scarps, and is only more extensive where the scarps give way to broad gently sloping valleys, as at Nadur and Xaghra and in part of Wied l-Isemu.

Description: A typical profile is

0 - 12"	Reddish brown, gravelly loamy sand or gravelly sandy loam; very gritty; single grain to very weak medium granular structure; loose.
12 - 27"	Yellowish red, gritty sandy loam, single grain to very weak medium granular structure.
27" plus	Off white, friable coarse-grained limestone.

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Table 22. Summary of chemical analyses of samples from the surface horizon of normal soils (means and extremes)

GENETIC CLASSIFICATION, SERIES AND TEXTURE TYPE		CHEMICAL PROPERTY	Organic matter per cent.	Active $CaCO_3$ per cent.	pH	Total phosphates per cent.	Readily available phosphates p.p.m.	Total exchangeable bases, milli-equivalents /100 gms.	Individual bases as per cent. of total				No. of samples
									Calcium	Magnesium	Sodium	Potassium	
CARBONATE	Nadur Ramla	Sand to sandy loam	0.7 1.4 1.9	2.1 8.2 14.7	7.82 8.34 8.73	0.05 0.12 0.20	—	18 24 33	88 91 94	4.3 6.5 8.6	0.6 0.8 1.1	1.0 2.3 2.6	5
RAW	San Lawrens Fiddien	Clay loam and light clay	0.9 1.6 2.1	13.3 14.8 15.3	7.72 8.50 8.65	0.05 0.14 0.23	4 14 50	29 38 45	81 85 89	7.7 11.3 17.9	0.7 1.0 1.6	1.2 2.0 3.3	7
SOILS	Fiddien	Heavy clay	1.4	13.0	8.70	0.19	22	24	95	24	5.8	4.8	1
XERO-	San Biagio Alcol	Sandy loam to clay	1.5 1.9 2.7	13.9 16.0 18.7	8.22 8.53 8.78	0.12 0.23 0.47	14 30 40	14 22 37	77 85 91	7.0 10.5 17.0	0.6 1.5 4.2	1.1 2.8 5.9	3
RENDZINAS	tal-Barrani	Silt loam, loam, clay loam	2.5 3.0 3.2	11.9 13.9 15.2	8.20 8.35 8.49	0.12 0.18 0.19	68 81 95	29 32 34	72 83 88	7.0 10.1 15.5	1.3 1.7 2.1	2.7 4.4 5.6	4
TERRA SOILS	Xaghra tac-Sigra	Clay, loam and clay	3.1 4.5 6.4	1.7 4.0 6.0	7.20 8.08 8.58	0.11 0.21 0.37	2 30 106	39 43 50	75 85 90	6.2 9.4 13.1	0.7 1.9 3.5	1.4 3.7 7.7	6

The soil is usually reddish in colour because of the small admixture of red sesquioxide material, but this is sometimes missing and then the soil is greyish or slightly yellowish, while the other soil characteristics are unchanged. A variant found on the glauconitic facies of the Greensand covers only a few acres - a deep greenish buff loamy sand. 134

Sometimes the fields occupied by the Nadur Series contain fallen blocks of Coralline Limestone, and often they are very small and strongly terraced. Frequently they are abandoned, or devoted to flowers, but where in use, vines, and to a small extent, tree fruits are grown. [311]

RAMLA SERIES

Parent material and location: The Ramla soils are formed on sands of contemporary dunes at Ramla in Gozo and sands from the Quaternary dunesand bed at Armier in North Malta, where they are mostly man-made having been excavated from the dunesand bed. Where blown sands have been deposited, a sequence of parent materials giving a complex of soils (The Armier complex) of Xaghra and Ramla series and intermediate types is also found; on Qortin tan-Nadur in Gozo and on Marfa Ridge, south of Armier.

Description of a Ramla Series soil not recently cultivated:

0 - ¼"	Oat grass emerging from a very thin A.F. layer composed of a dense mat of decaying grass leaves.
¼ - 7"	Brown sand; single grain structure, grains 'strung' on abundant grass roots; no stones; dry.
7 - 14"	Brown sand; single grain structure; slightly moist.
14 - 40" plus	Strong brown sand; single grain structure; no stones; moist.

In agricultural use without a grass cover, these soils show even less horizon differentiation; they are almost completely uniform, except where they have been 'maried' with other soil materials.

These soils are generally terraced, but the fields are relatively large and the terrace walls are not high. [311]

FIDDIEN SERIES

Parent material and location: The Fiddien Series is mainly developed from well-weathered calcareous Blue Clay but a heavy clay soil is found on the relatively unweathered (calcareous) Blue Clay which is sometimes saline or alkaline. In both cases the topsoil may show an admixture of downwashed red clay and sandy materials from the soils upslope on the scarps in which the Blue Clay is mainly found.

Usually the unweathered Blue Clay is near the surface at the head of the scarp slope so that the heavy clay is upslope from the lighter clay. On the gentler slopes the light clay is extensive, and in total area far exceeds the heavy type. The differentiation is important since the heavy type is occasionally alkaline or saline alkaline, because of the nature of its parent material.

Description:

Medium or heavy clay type

0 - 10"	Olive clay (dry); moderately well developed fine to medium sub-angular blocky in large prisms; plastic and sticky.
10 - 30"	Olive clay (moist); massive; plastic and sticky.
30" plus	Dark blue green clay, unweathered. In field sloping 10 degrees with a 'slump-shoring' 4 feet high terrace wall at the front face.

Clay loam and light clay type

0 - 16"	Grey brown gritty clay loam; weakly developed fine granular structure; sticky, moderately plastic; numerous glauconite particles.
16 - 30"	Grey brown gritty clay loam; better developed granular structure in angular blocky compound peds; more compact.
30" plus	Grey brown gritty clay loam; well developed coarse prismatic structure. In flat field 40 yards across with a 3-feet drop at one wall.

The fields in which this soil is found are usually either unterraced or have minimal terracing as in the descriptions above. Frequently unterraced slopes [311]

[134] [311] of over 30 degrees which are worked can be seen, but at slopes over 30 degrees the soil development is very poor, there may be gullying and the land is unworked.

SAN LAWRENZ SERIES

Parent material and location: The soils of this series are related to those of the Fiddien having as parent material Blue Clay and Globigerina Limestone alluvium and colluvium overlying Globigerina rock. In the normal sequence of soils down a scarp slope the series lies below the Fiddien and above the San Biagio.

Description:

0 - 1"	Brown clay loam; small granular structure; slightly stony; dry, powdery and loose.
1 - 13"	Brown fine sandy clay loam; weak medium granular structure; some gravel; very friable and slightly moist.
13 - 40"	Olive brown fine sandy clay loam to clay; well developed fine angular blocky structure; compact; plastic and sticky; moist.
40" plus	Pale brown fine sandy clay loam to clay; weak medium granular structure; gravelly, mostly decaying Globigerina rock.

[311] The fields in which the series is found are usually terraced, and sometimes have tall rock-face cuts at the back. The terraces are seldom very narrow, while those of the San Biagio series often are.

XERORENDZINAS

According to Kubiena (1953), the xerorendzina, also called dry rendzina, is a 'rendzina, ash grey in colour, usually very loose, when dry in general very powdery, with extremely high chalk content often also of water soluble salts, particularly gypsum; occurring in dry regions'. This soil is very similar to the South Russian serosem or grey earth of the dry steppes.

General description: The xerorendzina has an AC profile. The grey, shallow, loose, calcareous A horizon, with mull or mull-like rendzina moder humus form usually passes through a well developed whitish Ca horizon into hard parent rock C. It is sometimes difficult to distinguish from a carbonate raw soil, differing in little but the humus form. In Malta and Gozo two series are classified as xerorendzinas, one of which is not typical but is most conveniently called by that name.

The organic matter content of the surface horizon averaged over 2 per cent. in five samples from the San Biagio series, 1.7 per cent. in four samples of the Alcol series, but 3 per cent. in three samples of the tal-Barrani series rising to 6 per cent. in samples of uncultivated soil. The calcium carbonate content of these soils estimated from a small number of samples is 55 to 80 per cent. but some areas of the Alcol and tal-Barrani series probably contain less.

SAN BIAGIO SERIES

Parent material and location: This soil is developed from the weathered Upper Globigerina Limestones, and intercalated thin beds of iron-rich and phosphatic nodules, that appear both in the tall scarps of Malta and Gozo and in relatively flat plateaux. Consequently the sites on which the soils are developed are quite varied, and eroded and alluvial-colluvial phases are as common as a normal phase.

Description:

Eroded phase

0 - 7"	Very pale brown, silt loam, some gravel; moderately well developed medium sub-angular blocky structure; sticky and slightly plastic.
7 - 10"	Pale brown slightly heavier silt loam; moderate fine angular blocky structure.
10" plus	Very pale brown, silty, soft laminated rock.

Alluvial-colluvial phase

Surface just dry after recent rain has a thin, cracking, alluvium crust. 134

0 - 10" Pale brown silt loam; weak medium sub-angular blocky to crumb structure; plastic, non-sticky.

10 - 28" Pale brown, slightly heavier silt loam; slightly compact; with almost massive structure.

28 - 72" Pale brown silty clay loam; massive.

The normal phase is between these two extremes in its characteristics, and is usually of the silt loam type.

The landscape appearance is very uniform, and the fields in which this soil is found are normally strongly terraced, with cut-rock faces at the back of the terraces, from which fresh rock flour is derived during ploughing and is incorporated in the soil. Many fields have been partly produced by 'mining' in this manner, and some patches of soil are still carbonate raw soils. For agriculture in the islands this series is probably one of the most important since it is very extensive, and widely used. 311 134

ALCOL SERIES

Parent material and location: The Alcol series is developed on the valley loams (Quaternary and Recent) which are partly alluvial and partly colluvial and occur in the broader valley bottoms. They are erosion products of Terra, rendzina and carbonate raw soils, they are often stratified and are generally, but not always, well sorted. In general the material parent to the present soil is deep and of heavy texture, but a few sandy types are found, and intercalated gravel or boulder horizons occur. The differentiation of the soil from the parent material is difficult, since there are no well developed horizons except those produced by tillage. 134

General description:

1. Uniform material

0 - 6" Pale brown fine sandy clay loam; large to medium crumb structure; loose; very dry; numerous worm casts.

6 - 21" Pale brown silty clay loam; weak medium sub-angular blocky structure; moist; worm casts found.

21 - 72" Pale brown clay loam, passing to brown silty clay; weak medium sub-angular blocky structure becoming larger with depth.

72" plus Dark yellowish brown, similar to above, but very wet and possibly partly gleyed.

2. Stratified material

0 - 13" Reddish brown silty clay loam; moderately well developed medium granular structure; some worm casts.

13 - 16" Strong brown fine sandy clay loam; structure becoming laminar.

16 - 21" Reddish yellow very fine sandy loam; weak medium laminar structure; some gravel and cobbles; slightly moist.

22 - 45" Reddish yellow very fine sandy loam with many boulders.

46 - 60" Clay loam; very fine to fine angular blocky structure.

In general the fields in which this soil appears, are flat and consequently unterraced. [311]

In some places at the coast a saline ground water table is producing symptoms of salinity in the soil, but more usually the soils are merely strongly calcareous, neither saline or alkaline.

TAL-BARRANI SERIES

The tal-Barrani soils appear to be transitional between the San Biagio and Xaghra soils. They are developed mainly on Globigerina rocks of massive appearance and texture similar to the Franka, on which they are also occasionally found. The soils have been much disturbed and mixed in the making of terraces, and some have been artificially produced by man, by mixing rock flour and Terra soil material. [311]

Description:

0 - 10" Brown gravelly silt loam; with a thin crust (in dry weather) and below, moderately well developed crumb structure.

10 - 18" Brown gravelly clay loam becoming more gravelly towards the

base; weak fine sub-angular or angular blocky structure.
18 - 24" Brown gravelly loam or clay loam mixed with limestone rubble.
24" The formerly calcreted, broken surface of the Franka or similar rock.

The fields in which the tal-Barrani soils are found are often strongly terraced, for example, in the dissected Globigerina Limestone Plateau of south east Malta.

The hill top fields are naturally relatively flat and unterraced, but often show evidence of profound alteration of the rock floor by man.

TERRA SOILS

The terra soils found in Malta are principally earthy terra fuscas, but soils similar to siallitic terra rossa have been found, and there are certainly forms transitional between these two varieties.

The Terrae Calxis to which group the Terra soils belong, are according to Kubiena (1953), 'very mature, extensively weathered usually completely chalk free soils with ochre yellow, ochre brown to red coloured (B) horizons which contain iron in the form of ferric hydroxide with varying water content...'

Terra fuscas are 'usually humus deficient loamy soils with ochre yellow... to reddish brown colour on limestone rocks, which contain ferric hydroxide in the form of limonite', and earthy terra fusca is described as 'in the top soil, loose to slightly compacted, usually dark matt brown coloured terra fusca with good crumb structure'. The earthy terra fusca usually has an A(B)C profile, with a humus deficient, thin grey brown A horizon in which the humus form is generally mull. This horizon overlies a thicker reddish brown ferruginous (B) horizon which usually lies directly on the parent rock C horizon. The soil has a marked tendency to form crumbs and very low plasticity.

Terra rossa is described by Kubiena as a red soil, usually humus deficient and decalcified, rich in inorganic colloids containing ferric hydroxide in water deficient compounds, the siallitic terra rossa being 'Terra rossa with high colloid content, when wet highly plastic, viscous, characterised by a dense ground mass rich in silicic acid'. In general terms the profile is similar to that of the earthy terra fusca, but the soil colour is red and the plasticity is strikingly greater due to the different colloids. The structure is consequently different also, the peds being angular fragments produced by drying and shrinkage.

These soils have an organic matter content in the surface horizon of 4.5 per cent. (average of six samples) rather more in the case of uncultivated soils, rather less in the case of cultivated soils. This is slightly higher than the organic matter content of the tal-Barrani soils and very noticeably greater than that of the other xerorendzinas, and the carbonate raw soils. They are atypical of the variety in that they are not completely decalcified, containing in two profiles sampled 2 to 15 per cent. calcium carbonate, although much of the calcite in these soils has been blown in. This is emphasised by the greater calcium carbonate content in the surface horizons. (Two to four times greater than just above the rock.)

In the Maltese Islands the terra soils are found on the karst landscapes of the more massive limestones, that is the Upper and Lower Coralline Limestone and the Franka. The dominant variety is earthy terra fusca, and the mapping units used are described as such, ignoring the local transitions to terra rossa.

The terra soils can be divided into mapping units in various ways and it was found most convenient to map those appearing as patches between limestone lapiés as one group and the partly alluvial types in valley bottoms, dolines and on flat land without lapiés as another group. In the map (Fig. 27) they are not separated, but their agricultural potentialities are very different, because while in one case rock occupies from 10 to 50 per cent. of the surface and the rock slope may be steep, in the other case neither rock nor slope restricts the use of implements. In other respects they differ but little as can be seen from the descriptions below.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

Soil between lapiés

Surface	A few limestone stones and an incomplete cover of xerophytic plants.
0 - ¼"	Reddish brown gritty clay loam; moderately well developed medium crumb structure; hard.
¼ - 34"	Reddish brown or dark red clay; well developed fine angular blocky structure; very dry and very hard.
34" plus	Hard, white, semi-crystalline limestone with a calcreted surface.

Soil from site without lapiés

Surface	Bare after cultivation, a few stones.
0 - 15"	Dark yellowish red clay loam; medium crumb structure moderately well developed; dry.
15 - 36"	Yellowish red clay; moderate to well developed fine sub-angular blocky structure.
36"	Hard white crystalline limestone.

By definition of the mapping units these soils exist in fields which are unterraced and are often unenclosed.

COMPLEXES

The mapping units so far described are relatively simple, in that although they are not completely uniform the variations in the soils encompassed by each unit are small. However much of Malta has been very intensively used by man for a long period, and in some localities the effects on the soil are most pronounced - as described earlier. In such places the complication of the soil pattern is considerable and the mapping unit used is the complex. This denotes a fixed relation between a number of soil series alternating too rapidly to be separately delineated. The two units used covered: (1) the lands which have been quarried, where soil has subsequently been replaced in terraces below ground level; (2) the terraced terra soils (mainly karst-land). Both complexes are produced on land which formerly was covered by terra soils, and soils which it is possible to classify as terra are usually found to be most extensive now. However, in the quarrying and in the production of terraces by cutting away limestone lapiés, much rock flour and broken stone was produced, and much refuse and 'imported' soil was used to make up the soil. Consequently carbonate raw soils are to be found in many terraces, simulating the Nadur series, and the terra soils contain much material that is never found in the untilled soils of similar type. Between these extremes, soils which simulate the tal-Barrani Series are also to be found, presumably produced by the mixing of some terra soil with a great deal of rock flour.

These complexes are therefore dominantly disturbed terra soils with added matter, with numerous enclaves of xerorendzinas and carbonate raw soils. The alternation of the soils is so rapid that frequently within one small terrace 25 yards long by 8 yards wide all three types will appear, and the intensive terracing or quarrying is the distinguishing feature of these mapping units.

PROPERTIES AND UTILISATION OF THE SOILS

The interpretation of chemical analyses of calcareous soils is not always very clear. For example, the methods used for extracting exchangeable cations sometimes result in the extraction of calcium from calcium carbonate as well as from the exchange complex. Similarly figures given for readily available phosphate are of uncertain meaning, because the extractant cannot exactly simulate the ability of the plant to take up phosphorus which may be fixed by calcium carbonate. The figures given in Table 22 are therefore to be considered as a comparative guide. (It is thought that in this table there has probably not been much overestimation of calcium in the exchange complex because the highest measured values are correlated with the lowest values of calcium carbonate.) There is some difficulty of comparison with soils from other countries since the same analytical methods are not always used. Soils from

Spain, Sicily, Cyprus, Palestine and Australia of similar description, give roughly similar analyses, but it is not worthwhile to compare data obtained by methods of which the details are not closely standardised.

The carbonate raw soils have been divided into textural groups for convenience in describing properties and utilisation. The sands, loamy sands and sandy loams are very dry, easily worked, rapidly warming soils which where practicable, are mainly devoted to vines (Nadur series) and fruit trees (Nadur and Ramla series). Because of their light texture they have relatively low values for nutrients; however, they appear to give satisfactory crops, and are probably quite satisfactory. The clay loams and light clays (San Lawrenz and Fiddien series) are sticky, water retentive soils, usually fairly well structured, but hard and dry in late summer, and with a tendency towards an alkaline condition locally. In some parts of Malta they are used for a wide variety of crops, vines, tomatoes, cereals, and potatoes, but are more often devoted to sulla, as in Gnejna Valley and western Gozo. The Fiddien heavy clay, potentially valuable because of its high clay content, is usually alkaline, sometimes slightly saline and often has very bad water relations, so that it remains little used.

The carbonate raw soils, with one or two localities excepted, are terraced, or stand in steep slopes, so that there is little prospect of increasing the field unit size. Of the xerorendzinas, the San Biagio sandy loams and silty loams and the tal-Barrani loams are only unterraced on plateaux tops, while the Alcol clay loams and clays are almost never terraced. It is among these xerorendzinas, together with the level tas-Sigra soils in the karst areas that there is a chance of increasing field size sufficiently to allow mechanisation.

The San Biagio and Alcol series are, moreover, among the more easily worked soils, but appear, with the highest active calcium carbonate, low exchangeable bases, low organic matter and higher pH, to be among the chemically less-favoured soils. Observations of potash necrosis and iron chlorosis were made mainly on these soils. However, the reasonably satisfactory structure, easy tillage, and reasonably good water relations of these soils appear to compensate, for the soils are universally cultivated and appear to give satisfactory crops. Both series appear to be used for a wide range of crops, cereals, vines, rootcrops and market garden crops generally, the last mentioned particularly on irrigated land.

The tal-Barrani loams and clay loams, which comprise the brown rendzina soils, are found almost entirely in the heavily populated area of southern Malta, where they are intensively used, and almost universally terraced. They appear to be entirely devoted, apart from odd fruit trees along walls, to annual crops, principally cereals and potatoes. From the table (22) their chemical characteristics appear more favourable than those of most of the soils, and their structure and tillage properties appear to be fairly satisfactory. It is not known, however, whether they are more productive than, for example, the nearby San Biagio xerorendzinas.

The clay loams and clays of the Terra soils are all, potentially at least, rather fertile, as is revealed by the high figures for exchangeable bases, the rather unusually satisfactory figure (in Terra soils) for total phosphate, the relatively high organic matter content, lower pH and low active $CaCO_3$. However, where they occur as small soil puddles between lapiés the mode of working is problematic, and they are generally rather dry, compact, and difficult to cultivate. Here they are usually left uncultivated, and used for birdcatching and very rough grazing for sheep and goats, or occasionally very patchily for poor crops of cereals, prickly pear, fruits or flowers. The alluvial flats and flatter lands without surface lapiés are by contrast, usually heavily cultivated, bearing a wide variety of crops, especially in the damper valley bottoms, with potatoes most important on the non-alluvial flatlands. Where the land is worked intensively the depth of crumb-structured soil is greater, and in the valley bottoms, especially, the water relations seem to be improved.

The terraced Terra soils, that is, members of the various complexes, are usually very dry, and one of the unfavourable features of the carbonate raw soils, is the higher active calcium carbonate because of the incorporated rock flour.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

They seem to be largely devoted to cereals and potatoes, and in general give relatively poor crops. These soils are in several areas widely abandoned because they are uneconomic to work. 134 311

SOIL NEEDS

The needs of a soil, for the improvement of its fertility, are not simple to assess, and in the Maltese Islands at present they are not known. A fertile soil is considered as one which is in the optimum condition for the growth of crops, and this is dependent on a variety of factors, physical and biological as well as chemical. Air and water must be available, and man by cultivation and irrigation attempts to influence their disposition to favour his crops, just as by using fertilisers and weed or pest killers he attempts to influence the chemistry and biology of the soil.

PHYSICAL NEEDS

A soil which has a poor physical structure may be unable to support good crops, because water cannot be conducted to the plant easily enough, or because the soil aeration is poor. The heavy clay soils of the Fiddien series have poor structure, and it probably is the correlated difficulty of wetting the soil rather than the chemistry of the soil material (which often has a rather high concentration of exchangeable sodium and soluble salts) which causes it to be nearly useless for agriculture.

In the majority of cases the Maltese soils have a reasonably good structure, and the only other soils which appear to be ill-favoured are the heavy-textured soils of the Xaghra series. In this case the subsoil is often very compact indeed, and the separations between structural units are minimal. However, where such soils are well worked, and more particularly where they are irrigated, the structure seems to be much improved, partly no doubt because of the increased and active microfauna. While irrigation is probably difficult to extend, the use of improved cultural practices on these soils would probably produce an increase in the soil organic matter content and improvement of the structure. Among such practices the use of nitrogenous fertilisers, use of improved rotations, encouragement of root growth, avoidance of oxidation of root-derived organic matter through unnecessary turning over of the soil, and the avoidance of pulling cereals as a method of harvesting, might cause considerable improvement. The application of animal manure in irrigation water as already practised locally in Malta also appears to be effective in increasing organic matter content of the soil. 134 242

One of the chief problems of all crops in the Maltese Islands, is water. Certain of the lighter textured soils are extremely dry, and conservation of rainwater rather than extension of irrigation must be the answer because domestic water needs are already difficult to satisfy. Apart from practices designed to diminish evaporation loss, especially early removal of weeds by hoeing, it is probable that increasing the organic matter content would considerably increase the ability of the soil to hold water. But another simple possible method would be to marl some of the lighter soils with the calcareous clay, e.g. Fiddien heavy clay, which is not in agricultural use. (This would in addition possibly make more nutrients available.) 134 [312]

As far as aeration is concerned, it seems unlikely that it is deficient in many soils at present; but use of a rototiller (common in Malta) is believed to decrease aeration, and this could be investigated quite simply. It is possible that an excess of soil CO_2 would be beneficial in calcareous soils, reducing the pH of the soil solution to a level at which there is greater availability of most nutrients; and particularly those, such as phosphorus, which are likely to be deficient.

CHEMICAL NEEDS

Despite some other possible deficiencies it seems likely that nutrient

[TEXT CONTINUES ON P. 97]

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deficiencies are likely to be the most important factor involved in soils of low fertility in the Maltese Islands. However, it is not possible to say immediately what these are because

(1) There is no simple relation between analytical data and availability of nutrients to plants.
(2) Existing analytical data are few and they are not correlated with field crop performance.
(3) Satisfactory chemical data for calcareous soils are more than usually difficult to obtain and compare.

Despite the generally healthy appearance of the crops, some symptoms of nutrient deficiencies have been observed, and remembering well known characteristics of calcareous soils, it is obvious that only experimental comparison of fertiliser application with crop yield, can give any definite answers about needs. Such experiments need to be of a form capable of statistical analysis, to enable tests of significance to be applied and to reveal interactions.

The first step should be to set up a simple series of long term trial plots in sites typical of each soil, using only one crop or rotation and only N, P and K fertilisers, each at two levels. Later, foliar analysis or an 'application to plant' method could be used to examine crops for specific deficiencies in order to make a more complete picture. Again, at a late stage alternative fertilisers might be compared, and time and mode of application, although until new data are obtained it is likely that early application, effective elsewhere, may be beneficial in Malta also.

It should be borne in mind that (1) effects of past management may have upset the natural status of the soil - the addition of town refuse is a case in point, as in addition to actual toxins, the microbial population may be unfavourable. (2) Effects of infestation by parasites and fungi, or diseased remains may remain which will invalidate a trial. This needs strong emphasis since much soil disturbance has taken place in Malta, and the addition of town refuse is common. Further, many plots have been observed to be infested with broomrape, which is never combated, and others to exhibit root damage produced by insect larvae. The elimination of these alone would in any case result in considerable improvement in crops.

The symptoms of deficiencies which have been observed are potash necrosis of fruit tree leaves, and lime induced iron chlorosis of citrus tree leaves, particularly on the xerorendzinas and carbonate raw soils. In addition it is well known that phosphorus fixation takes place rapidly in contact with calcium carbonate, and is most complete when the latter is in a state of fine subdivision (Gonsales Garcia and Tristan Matos, 1956). Thus deficiencies of these nutrients are likely to be discovered by experiment, and although the author has not observed symptoms of nitrogen deficiency, the low organic matter content of the soil, and the lack of conservation of nitrogen make it seem likely that it will be found deficient in some localities. Sulphur, sometimes found lacking in marly soils (like Fiddien series) in Spain, is likely to be found deficient, and although ordinary superphosphate supplies sulphur as well as phosphorus, it seems possible that elemental sulphur as used in Spain may be more effective. Minor nutrients, for example iron, may be supplied by chelates like those used successfully in arid parts of the U.S.A. (Kuykendall et al. 1957), or less expensive spraying methods.

SALINITY

A few soils in Malta are affected by a saline ground water, a few plots are being irrigated with brackish water, and, although this has not been directly observed, probably some are affected by saline spray. The result is an increasing soluble salt content in the lower part of the profile, but up to the present the concentration has not been great enough to cause very noticeable effects on crops, although poor structure is noticeable in two profiles examined. The avoidance of ill effects due to saline waters can be effected by making certain that through-drainage takes place from time to time, in order to carry away some of the dissolved salts. The use of soluble calcium salts in the irrigation

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134 water occasionally is a further aid. This is difficult or impossible, however, without drains and irrigation, so that soils with a saline ground water, are probably irremediable, but they may not in any case be worsening very rapidly.

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KUYKENDALL et al. (1957) - Soil Science 84..1957. pp. 77-86.

ACKNOWLEDGMENTS

122 The author is indebted to the Colonial Office, under whose auspices the field work was carried out, for permission to publish this account.

His sincere thanks are due to Dr. H. Greene and Dr. D. A. Osmond for criticism and 114 guidance, to the staff of the Analysis Section of the Macaulay Institute under Dr. H. G. M. 128 Hardie who performed the analyses, and to Mrs. D. Sutton for help in the preparation of the typescript.

[p. 98-A]

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

B. Slope Analysis, Erosion and Tillage

The slope map (Fig. 28) is a further illustration of the regional variations in the physical landscape which were described in some detail in Chapter I. The most clearly marked feature is the division into Western Scarplands and Central and Eastern Hills and Plains. In the former, gently sloping land (slopes less than 1 in 20) is confined to basins and to a few very limited parts of the plateau uplands. Snarply accidented topography and thus steep slopes are widely developed in this region, reflecting its complex structure. Slopes of gradients ranging from 1 in 7 to 1 in 2.5 occur along the faulted edges of all the plateau blocks as well as in the zone of Blue Clay outcrops which separates them from the Globigerina lands to the east. The various uplifted blocks themselves generally have undulating summits with slopes between 1 in 20 and 1 in 7. In the Central and Eastern Hills and Plains, the position is reversed. Over these parts of the Island gently sloping land (gradient less than 1 in 20) covers at least half the area and really steep slopes (greater than 1 in 7) are confined to coastal cliffs and a few valley incisions, the latter case being particularly widespread in the Naxxar-Gharghur hills.

There is, however, no simple correlation between steepness of slope and the presence or absence of cultivation. Indeed, the greater proportion of the land shown on the map as having a gradient greater than 1 in 7 is in fact still under the plough. The distribution of waste and abandoned land, occurring on plateau summit rather than scarp face, is a function of rock-type, exposure and various social and economic factors (see p. 227) rather than of gradient. That gradient only in extreme cases sets absolute limits to the extent of cultivation is illustrated by the Rdum zone of the south-west coast where, in the Rdum ta'Dingli and the Rdum tal-Lunzjata, intensive cultivation is maintained in land whose average gradient is greater than 1 in 2.5.

Though gradient has little direct effect on the pattern of farmland and waste, it obviously has much to do with the physical effort involved in maintaining a particular piece of land in cultivation. Even here, the control is by no means absolute. The problems of retaining a soil cover are much less serious in steeply sloping districts where thick, heavy soils are derived from the Blue Clay, than in areas of similar gradient where the parent rock is of Globigerina or Coralline Limestone. In the latter case, soils are thin and coarse, *'campi artificiale'* are frequently found and the soil, once removed, is not easily replaced either by natural or by human agencies.

The character of field boundaries illustrates this point. In Blue Clay areas they are generally low ramps rather than retaining walls, whereas in steeply sloping limestone areas, walls of great height and thickness are necessary to maintain a rudimentary soil cover. Field shape and size (see Fig. 68 and p.185) are also relevant. Long, narrow, ribbon-like fields are characteristic of steep slopes in limestone districts, while in Blue Clay areas fields are generally much larger, despite steep gradients.

The dangers consequent upon careless tillage and failure to maintain boundary walls are greatest on slopes steeper than 1 in 7, in areas where the soil cover is thin and is either artificial or derived from limestone rocks. The abandonment or neglect of a single field, the breaking down of a single wall quickly lead, in such areas, to damage above and below the neglected field and may eventually affect a whole flight of terraces, even driving away other cultivators who are unable to bear any increased load of maintenance work on their walls and fields. While outstandingly heavy storms can cause damage to land of all types (see p. 67), in areas falling within the category indicated above, constant vigilance is necessary at all times, both in the use of traditional methods of tillage and particularly in the introduction of new ones.

[P. 99]

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1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6
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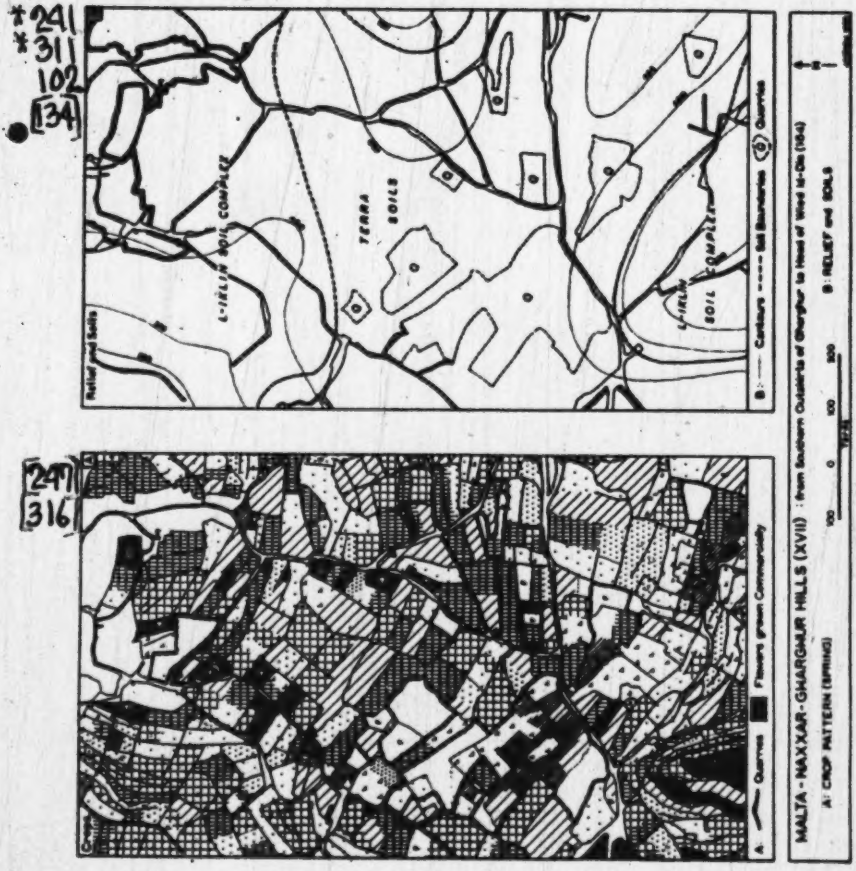

Fig. 118 Malta: Naxxar-Gharghur Hills.

1: Bowen-Jones et al. K-5 (1955-1958) 1961

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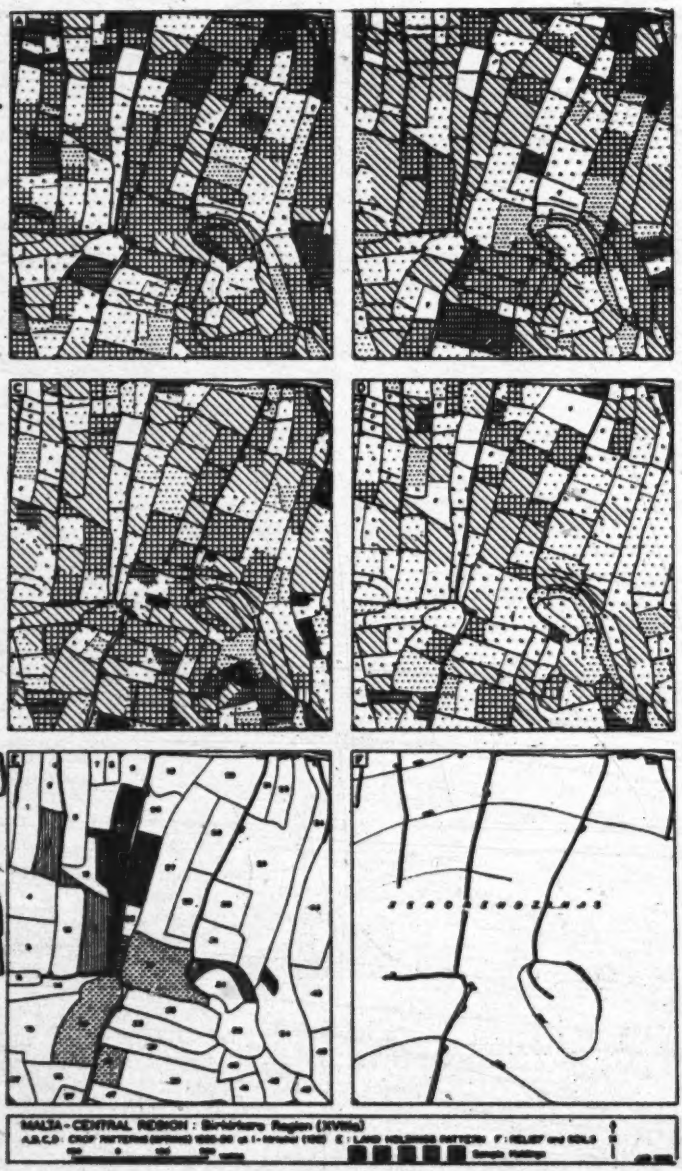

Fig. 116 Malta: Central Region: Birkirkara Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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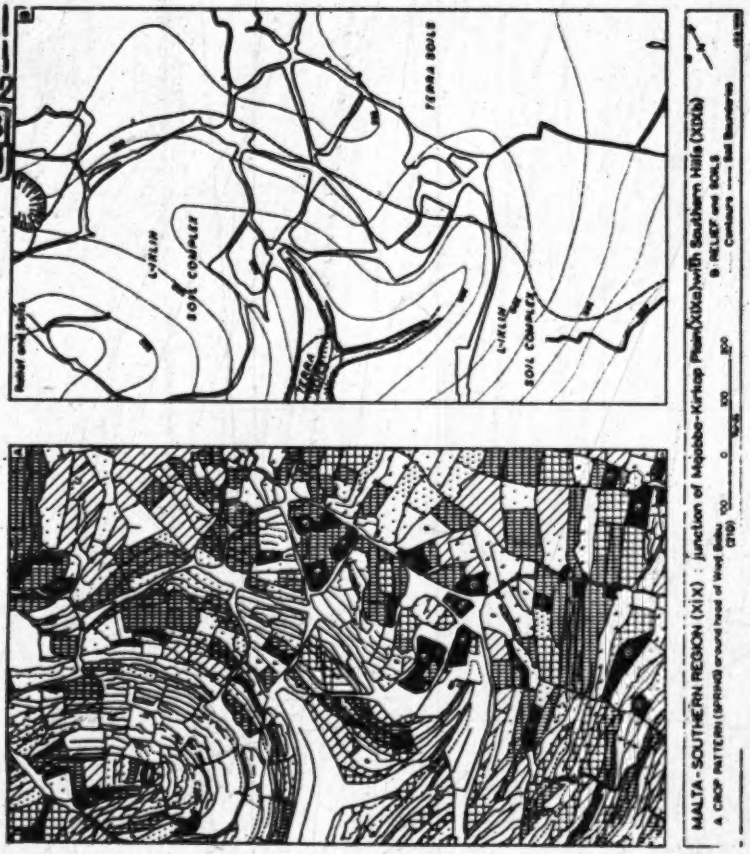

Fig. 121 Malta: Southern Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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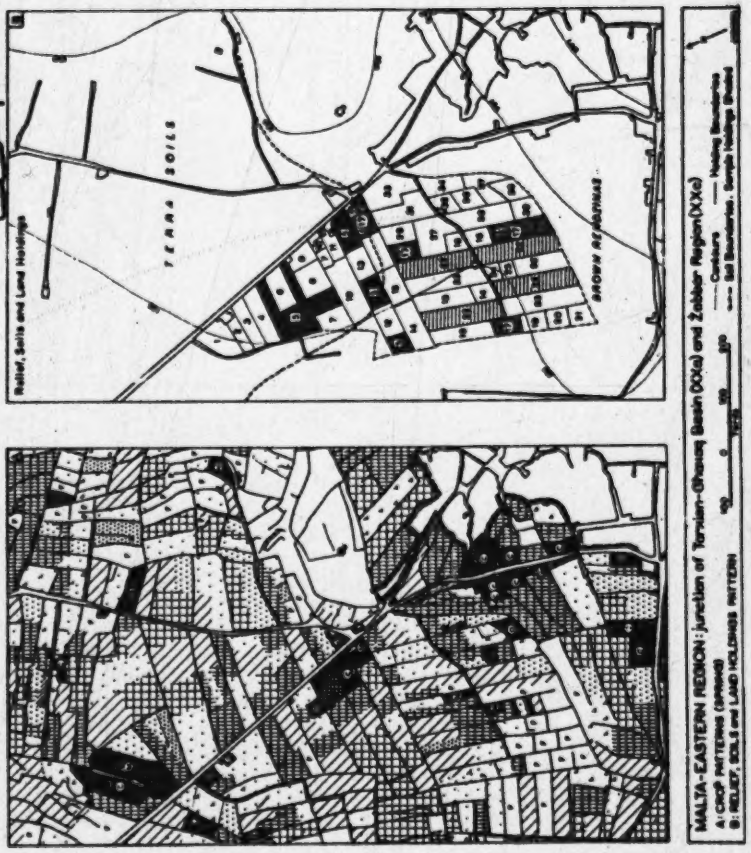

Fig. 122 Malta: Eastern Region: Tarxien-Ghaxaq Basin.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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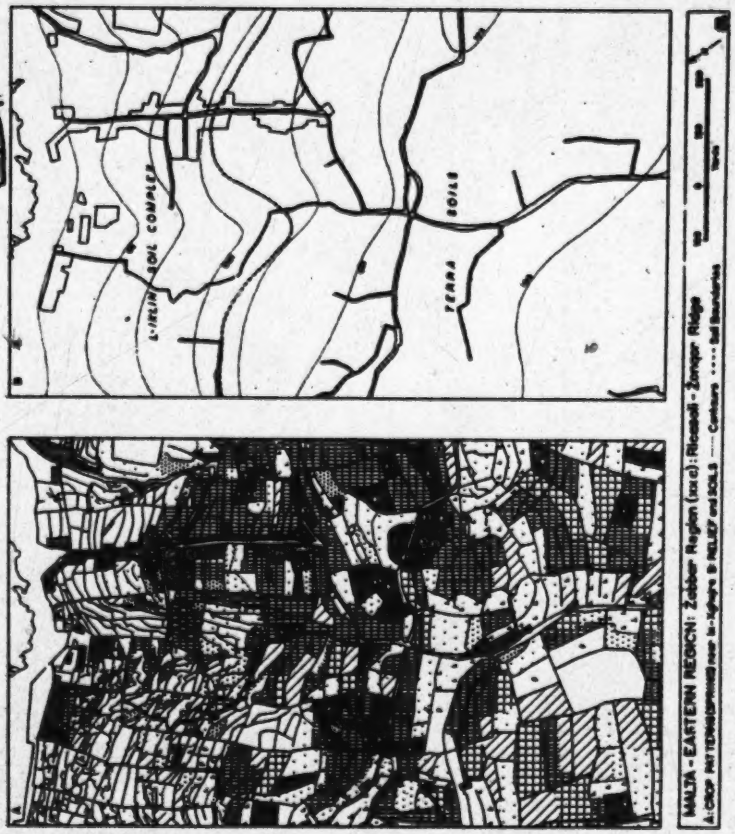

Fig. 123 Malta: Eastern Region: Żabbar Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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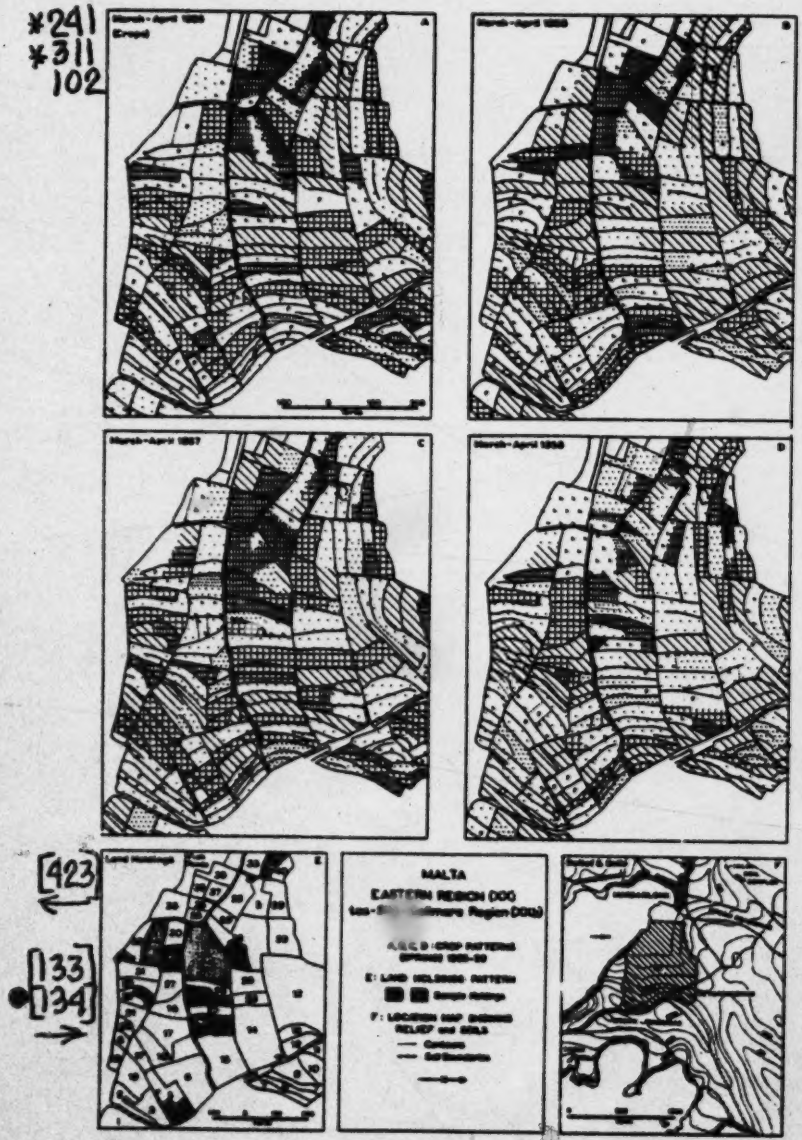

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Fig. 124 Malta: Eastern Region: tas-Silġ Delimara.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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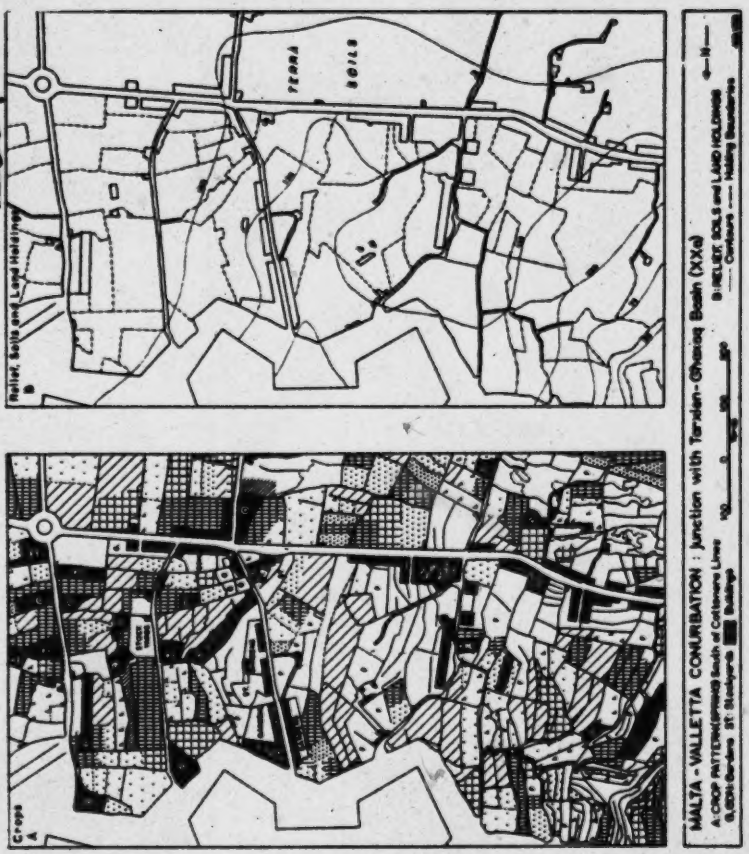

Fig. 125 Malta: Valletta Conurbation.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
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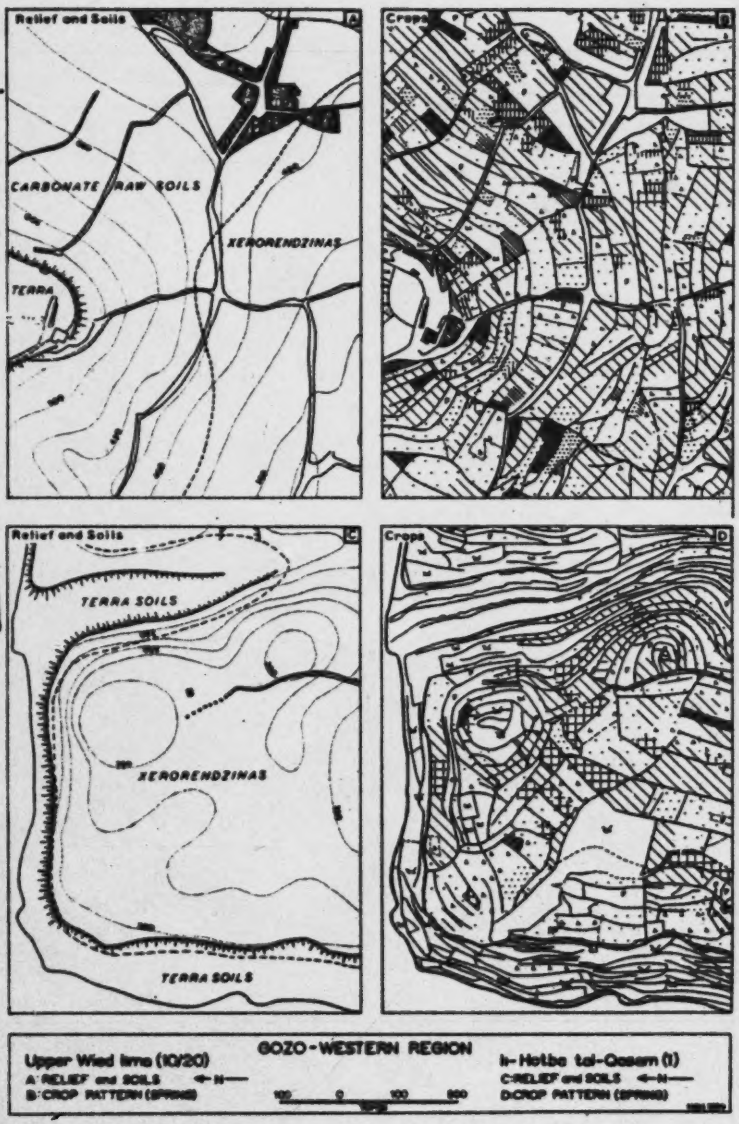

Fig. 126 Gozo: Western Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6
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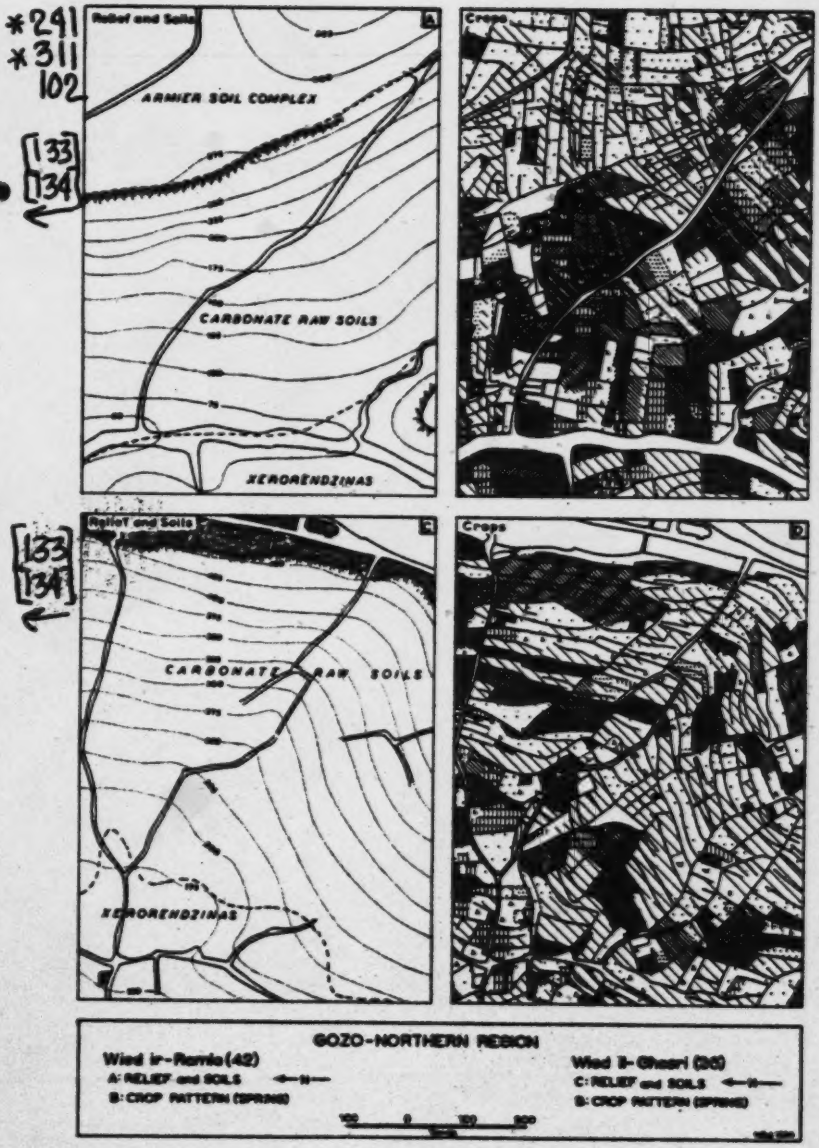


Fig. 127 Gozo: Northern Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6
GOZO

*241
*311
102

[33]
[34]

[423]

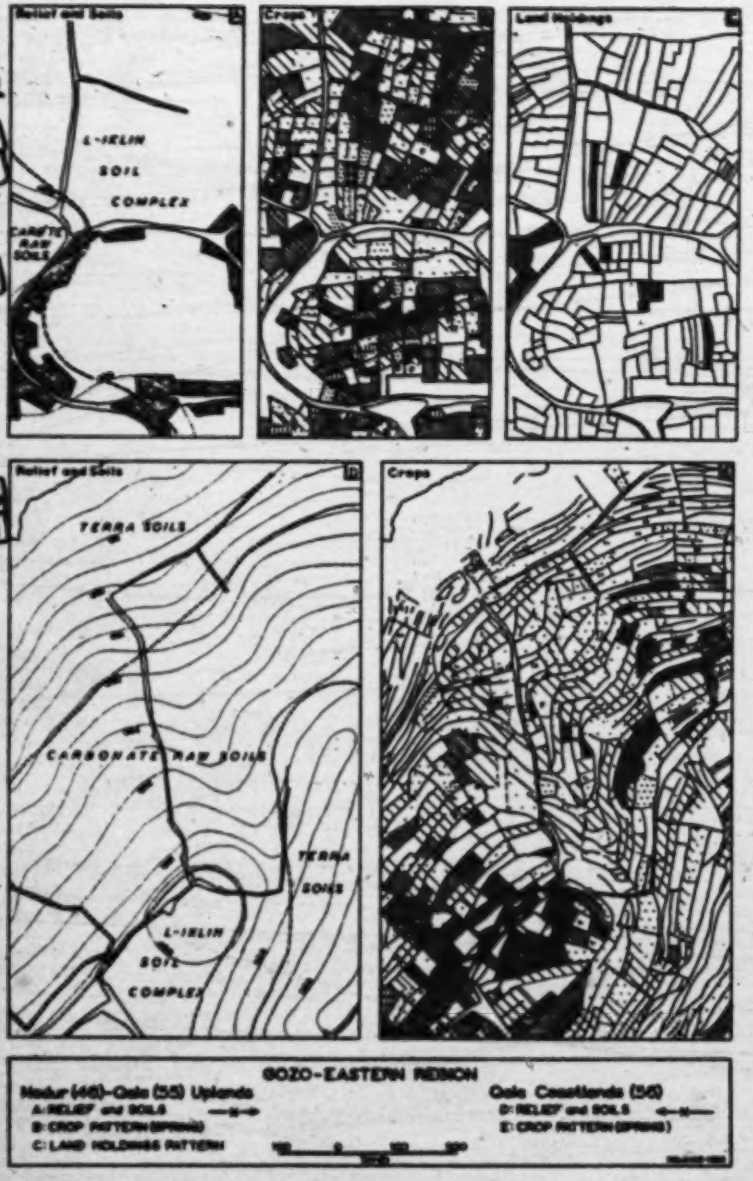
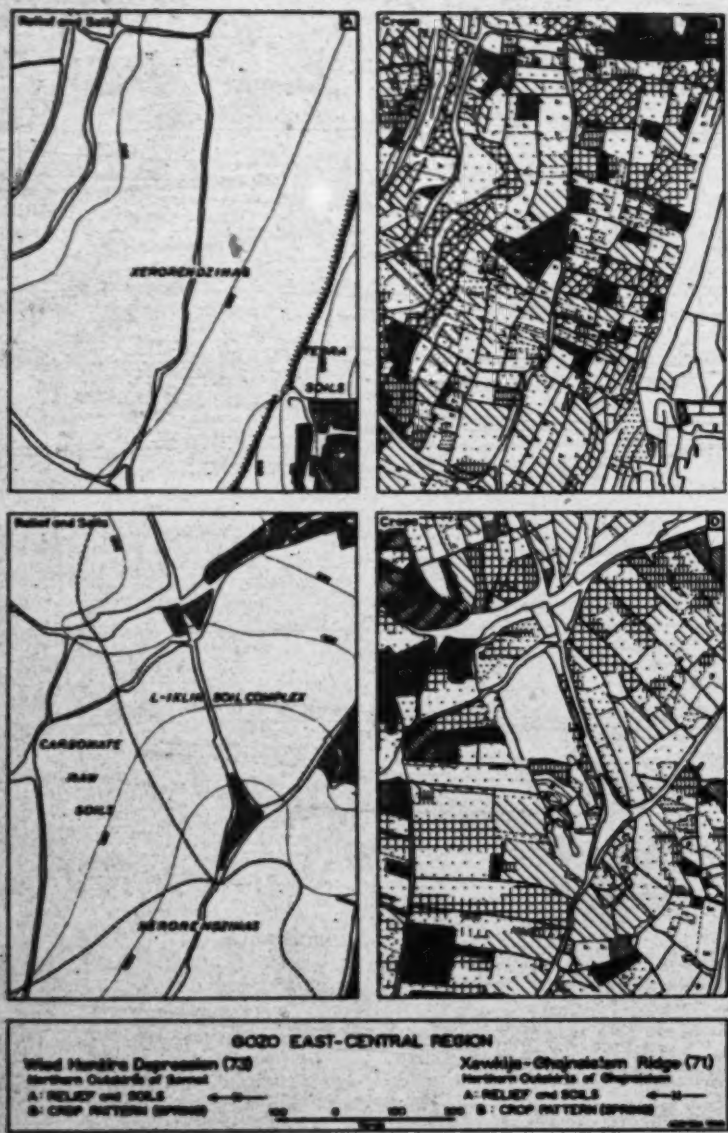


Fig. 129 Gozo: Eastern Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6
GOZO

241*
311*
102



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[133]
[134]

Fig. 131 Gozo: East-Central Region.

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6
Gozo

Fig. 132 Gozo: East-Central Region: Xewkija-Ghajnsielem Ridge.

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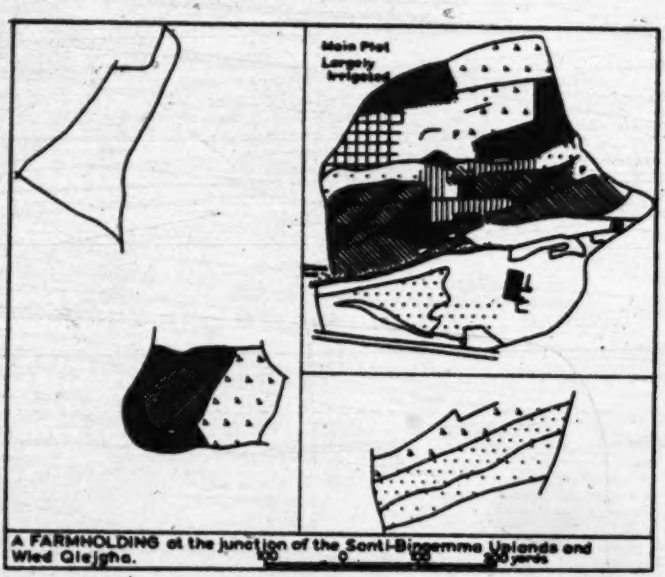

Fig. 141 A farmholding at the junction of the Santi-Binġemma Uplands and Wied Qlejgha.

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Upper Coralline aquifers overlying outcropping Blue Clay. The main supply, from a fissured Coralline cave now piped into a cistern, has only failed once (1950) since 1921. Water needs conserving in summer and is then only applied to special crops. Minor supplies come from 'wet weather' springs on Blue Clay slopes.

●134
241

Soils - deep, weathered marls with thin clay beds, these latter being used for marling the Upper Coralline lands. In winter, the clay beds are too wet for most crops, e.g. during the 1953-54 season an attempt to grow wheat failed completely and, on 2nd April, 1955, drainage holes were necessary to hasten the percolation of surplus water in some fields. In summer, the clays need careful tilling in order to avoid caking. Produce is mainly for sale in Rabat market.

241 3. THE FULL-TIME DRYLAND ARABLE FARMER

This group is numerically and areally the most important. It also tends to set the general standard of farming.

E - The first example of this group works land in Region CXX, the Tarxien-Ghaxaq Basin. A full-time farmer with two dependants with a fairly concentrated holding of 32 *tmien* (8.7 acres), used as follows in spring:-

3.6	*tmien* of Sulla
5	*tmien* of Potatoes
5	*tmien* of Wheat
5	*tmien* of Barley
.5	*tmien* of Broad Beans (vegetable)
19.1	

The remainder is under onions, aniseed, cumin, fallow and forages. The best land has 30 inches of soil and is rented at 26s. per *tomna*. The poorer

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

132 The Maltese climate is characterised by variability rather than by extremes. Most of the complex elemental combinations, as far as we can tell at the moment, tend to inhibit soil and plant development under natural conditions.

The annual precipitation average of 20.5 inches is largely meaningless - the variations from one year to another for each month in which there has been recorded any significant rainfall are all several times the mean values. Very high insolation and evaporation rates, from the end of April to the beginning of October, further reduce the effectiveness of scanty and variable precipitation. Much of the rainfall of spring and autumn is associated with violent frontal storms and is sufficiently concentrated in incidence to produce ephemeral torrents and cause considerable erosion.

Wind incidence is of peculiar importance. The maritime air streams are generally of high humidity and velocity. The dominant Northerlies, in particular the stormy *Majjistral*, with high humidity and relatively low temperatures, have a biological effect bleak enough to produce a very clear ecological pattern controlled by aspect and shelter. The soil line in the lee of the ridges which lie transverse to these North to West winds, rises higher to the south east with the cumulative sheltering effect. On a small scale, windbreaks of stones, wattle hurdles and even cereal hedges, become of importance. The *Xlokk* comes as a warm humid wind of usually sufficient velocity to force plant transpiration rates above the critical points. The occasional humid still air conditions in winter delay germination and encourage fungus diseases while all summer winds heighten evaporation rates and cause actual soil blowing.

One of the few biologically favourable climatic features is the absence of a thermal dormant season. Mean monthly temperatures are consistently above 50° Fahrenheit, frosts are very rare, and diurnal ranges small. On the other hand, the associated high summer temperatures even though ameliorated by sea breezes produce considerable physiological troubles in plants and livestock. It is significant that over 80 per cent. of the flora now found in Malta are of North African rather than European type.

133 In the absence of human interference Malta must have been, as it still is in many areas, largely a barren karstic waste relieved only by a few basins and plains such as the Wied tal-Pwales and the Wied il-Ghasel. On the hill and ridge tops Terra Rossa formation takes place in solution hollows. On all slopes with gradients greater than 5 per cent., and on all but the most wind sheltered flatlands corrasion and movement, often exposing great stretches of bare rock, are dominant. Only in a few basins, such as the erosional Wied ta'Mazza or the tectonic Bur Marrad in the Wied il-Ghasel, does deposition become important.

In this harsh environment man created the land on which he could live.

134 311 Malta has few true soils but, rather, laboriously garnered and transported inorganic material, carefully built up with humic additions, terraced and walled into place and irrigated wherever possible. For millennia this making of *'campi artificiale'* has gone on and may still be observed, so that some two-thirds of what Bernard Shaw called 'a heap of stones' is now cultivable land. This process of the extension first of hydroponics and then of true farming over bare rock and the reclamation of unhealthy lowland has meant the creation of new and precarious balances. The artificially produced thin pseudo-soil is not self perpetuating. The underlying rock must be regularly chipped away, the solution hollows periodically harvested. The texture must be maintained by the addition of organic matter and by frequent working. The level of nutrients must be kept up with dung and fertilisers and the water content supplemented by irrigation. The terrace walls need constant repair.

In each case there is a sharply critical point beyond which action spells danger. The use of refuse brings bacterial and virus infections, frequent tillage produces a clean surface vulnerable to erosion, the use of irrigation water and artificial fertilisers raises soil salinity. Extension of the soil cover decreases the rate of percolation replenishment of the subterranean aquifers by rain water. Malta is now in fact living on capital as far as water is concerned.

241 There have been similar critical points in crop values. When water is available, the potential crop range is large - bananas grow in barley patches, date-

1: Bowen-Jones et al. K-5 (1955-1958) 1961
EZ6 Malta EZ6

palms and pomegranates alongside potatoes - but in no case are conditions optimal or yields very good. In the comparatively closed economies of the past this mattered little; in an era of world trade and world markets Malta has now been left behind. Large-scale cotton production has virtually ceased and that of citrus fruit is declining; viticulture is of low standard and the olive tree very rare. Cereals can now provide only a tiny fraction of local needs while fodder production is limited in season and type by water shortage.

The critical phase in the social and economic reactions to the physical situation has also been reached. In the simple peasant communities of the past, the creative manual effort was necessarily associated with a low valuation of individual human effort and an arduous and restricted life. Now, however, economic and social opportunities and desires have widened and with them has come impatience with the demands imposed by the artificial landscape.

Higher per capita productivity to assure more freedom and leisure is only quickly attainable by technical and mechanical innovation. It is just such innovation that is impossible on a large scale on the land of Malta.

The slope analysis map (Fig. 28) illustrates one aspect of the problem. Maltese soil 12 inches deep needs, as a minimum amount, terracing at horizontal intervals of about 20 feet. Anything wider in the way of fields or a deeper soil makes essential increasingly higher and stronger retaining walls. The problem is such that considerable control is exercised by dip as well as gradient. The amount of labour involved in maintenance is heartbreaking by modern standards and yet, without it, erosion is quickly followed by the complete stripping away of the soil down to bare rock. The scale of farming operations often has to be very small - the planting of single rows of beans, of single trees, the sowing of chick-peas in rock crevices. Power and tool application is severely restricted. Small and light implements and single draught animals or more recently 'rotavators' alone can negotiate this type of terrain and work very thin soils covering rock platforms. The dangerous effect of the abandonment of any land is obvious. The past has in fact enchained the present. If cultivation is to continue then in order to preserve the artificial ecological balance, created with such effort over the centuries, a social imbalance will become even stronger. Whatever the scale of farming the farmer will always have to grub for soil, build his terraces, carry his plough or manhandle his rotavator for long hours under conditions that will seem less attractive even than those of casual dockside and urban labour.

The first point then is that the landscape indicates how human effort is pinned down by the artificial environment and how restive man is becoming.

The second theme is concerned with the reasons for the historical process of what really amounts to landscape gardening, and with the underlying implications.

Malta's wealth, in historical times at least, has come from a large extra-territorially derived income which has resulted from the Island's positional value. It is possible that even in prehistoric times Malta was never self-sufficient. The great temple building cultures of Malta and Gozo may well have maintained their master masons on imported wealth. Certainly Carthaginians, Romans, Byzantines, Arabs and Normans all occupied Malta because of its strategic position and took wealth in rather than removed it. The Order of St. John held it as an outpost of Christendom maintained by the Knights' possessions on the European mainland. Britain has similarly supported the Island's economy in return for its use as a naval, military and more recently a strategic air centre. Because of Malta's positional importance its inhabitants found it necessary and worth while to create agricultural resources. Because Malta has usually been an outpost the society and its works have attained the unstable equilibrium of a siege life.

At least since Arab occupation a duality has appeared in the community. Earliest at Mdina, later in the Three Cities, then in Valletta and the whole Grand Harbour complex, and now around the naval, military and air bases, the garrisons have formed successive nuclei of a cosmopolitan and sophisticated community. This community, literate, trained in the professions and trades has

1 A [See pp. 98-B and 98-C -- Analyst]

2: Boissevain E-5 (1960-1961) 1965
EZ6 Malta EZ6

CHAPTER I

The Background

Malta and her sister islands, Gozo and Comino, lie midway between Gibraltar and Lebanon, at almost the exact geographical centre of the Mediterranean. Sicily lies just 58 miles to the north, Tripoli 220 miles due south and Tunis slightly over 200 miles to the west. The Maltese archipelago thus forms a port of call between Europe and North Africa, between the Christian and the Moslem worlds. The Maltese have been in contact with both for centuries, and the cultures of both have contributed many traits which the islanders have adapted to their own use.

Malta, the largest and southernmost island, is seventeen miles long and nine miles wide, and covers an area of 95 square miles. Gozo is only nine miles by five miles, with an area of 26 square miles. Finally, the little island of Comino, which lies in the three-mile-wide channel separating the two larger islands, has an area of one square mile.

The islands are composed entirely of tertiary limestone, and the soil consists of clays and marls. Although the land rises to a maximum of little more than 800 feet near Dingli, the terrain is varied, and often broken, with jagged escarpments falling into narrow valleys, which run out to level fields. A visitor to the islands, especially during the long dry summer, is struck at once by the absence of vegetation and the rocky aspect of the countryside. This is, in part, a false impression, for although there are few trees, rubble retaining and boundary walls hide the network of small cultivated fields. Occasionally, the dark green foliage of a carob or olive tree reaches over these stone enclosures to add a sudden splash of colour to the shimmering white-yellow of the summer landscape.

The soft yellow limestone gives a continuity to the scenery. Houses, villages and whole towns seem to grow up out of the rocky matrix from which they are built, and from which they are distinguished only by the regular outline of the buildings against

[text continues on p. 3]

the money being repaid." Niklaws observes that "Farming depends on nature" and he points to the storms of late 1957 as an example of the way in which the farmer may suffer irreparable and unexpected loss. On this occasion standing crops, soil and field walls were washed away and the whole planting and sowing cycle interrupted.

The brothers also complain of the present marketing regime which, they claim, militates unfairly against the producing farmer. "There is no guaranteed market for field crops sold and there are too many middlemen taking too large a cut." The brothers cling to the typical idea in Maltese farming that the 'Government ought to guarantee sales of field-produce in the same way that milk sales are guaranteed'. They have little appreciation of ruling market conditions outside Malta. Niklaws says that the labour of the brothers is not considered as a cost - "if it were there would be no money left". They appear to have been in the habit of employing labour for many years and today have a full-time cow-hand. Only one of the brothers is married. Four of the brothers have therefore only themselves to support on their share in the income from this well-organized and apparently remunerative partnership, situated in one of the best dry-farming regions of Malta.

CASE VIII : Summary.

(Working partnership of five brothers with diversified production.)

A. Land.

c.70 tmien of unirrigated land in Żebbuġ Region. 16 field plots in 11 parcels in a linear arrangement extending over 2½ miles in the Żebbuġ and Wied tal-Isqof areas. All land lies in one of the best dry-farming regions of Malta on good marled Xero-rendzina and Carbonate Raw Soils.

[134]

B. Utilisation. (i) Typical arrangement.

		Winter	Summer
Plot 1.	8½ tmien	Potatoes & Wheat	Tomatoes & Cauliflower
Plot 2.	1 tmien	Potatoes	Cattle exercise yard
Plot 3.	1½ tmien	Onions, Potatoes, Vines.	Legumes & Vines
Plot 4.	3 tmien	Potatoes & Vegetables.	Cauliflowers & Vegetables.
Plot 5.	2½ tmien	Sulla & Barley	Tomatoes
Plot 6.	1½ tmien	Cereals, Cauliflowers & Tomatoes	
Plot 7.	2 tmien	Wheat, Cauliflowers & Tomatoes	
Plot 8.	7½ tmien	Sulla	Cauliflowers & Tomatoes
		Cauliflowers, Wheat & Tomatoes	
Plot 9.	2 tmien	Vines	
Plot 10.	2½ tmien	Potatoes	Tomatoes & Cauliflower
Plot 11.	21 tmien	Vines (5½ tmien)	
		Barley	Sulla, Tomatoes
		Vetches	Fallow
Plot 12.	2½ tmien	Potatoes	Sulla
Plot 13.	1½ tmien	Wheat	Sulla, Vetches
Plot 14.	2½ tmien	Fallow, Melons, Tomatoes & Cauliflower	
Plot 15.	5½ tmien	Citrus Orchard	
		Tomatoes	
Plot 16.	1½ tmien	Cauliflower	Tomatoes

*159 29 31 The larger pieces of ground are put to potatoes, tomatoes, artichokes (qaqoċċ), marrows (qargħa bagħli), and a variety of vegetables. Fig, pomegranate and other trees fill the corners and edges of fields and a tomato seed-bed and a hen-[406] house also manage to find space in odd corners. Two machine-[343] driven pumps and a few tiny storage and shelter rooms complete the scene. The block of fields is in a small sheltered •[134] valley on the east coast of the Island and contains clay soils tending to be heavy, especially in wet weather.

*159 241 433 434 829 [464] Pietru's irrigable fields are clearly the focus of his interest and attention. He observes that they bring in a greater profit per man/day of effort than do the dry fields which he prefers to leave to the wife and children to cultivate on a more casual basis. Nevertheless Pietru is not able to make a profitable concern of his farm despite his own heavy working schedule and the full-time assistance of at least two teenage children. In fact he is poor enough to qualify for C.A.R.E.[27] food distributions. He is however content with farming as an occupation and critical only of the lack of adequate remuneration. His attitude is to 'make the most' of his farm within current limitations. He was a [474] founder member of a C.A.R.E. sponsored tractor co-operative (Section 2) although he admits that when the project was first suggested he was opposed to it on the grounds of rather having the money than letting the Government get it. This belief that the Government is behind everything is characteristic (Section 4). C.A.R.E. is of course an independent organization distributing American surplus food and equipment.

*159 178 241 Thus Pietru's son who works full-time with his father is faced with his father's industry and enthusiasm for farming on the one hand but he can see for himself the apparent impossibility of achieving anything above low living standards. Whether he will join the trek away from farming is not yet clear. His educational standard is lower than is the case among many of his generation and it may be that he will have difficulty in finding employment outside farming.

If Pietru can improve the efficiency and profitabily of his farm (by using better suited crops, new methods and new equipment with Government financial and advisory assistance) his son might be persuaded to stay in it. The problem of Maltese farming today is that there are very few young men in the farming industry who show as much inclination to [426] stay on the land. The Government has been keen to assist [654] the full-time farmer with loans and other help in an effort to encourage him to stay on the land and to develop agriculture to the full but it has done comparatively little for the young men in farming who are, in the long term view at least, the more important. If they cannot be induced to stay in farming the industry would appear to be doomed.

*159 433 451 land but maintains that it is becoming uneconomic because of high labour costs and difficulty of raising yields any further.

(iii) Makes careful practical distinctions between types of land:

*159 134 241
- some fields have 8 inches of soil on rock platform and these can only be worked by hand.
- deeper soils up to 3 feet thick need periodic deep plowing although this may result in the bringing to the surface of "newba" (or "melh" - salt) - sub-surface saline concentration with harmful results.
- red and white soils have different characteristics for tillage and crop-growth.
- notes the presence of a thin, very hard weathered layer on top of Globigerina bed rock. This "skorča tal-blat" is believed to prevent the movement of moisture from the rock water-table to overlying soil.

*159 159 626 (iv) In spite of literacy, general initiative and acumen he is conservative about trying new ideas. Here, as elsewhere, the chief obstacle appears to be social rather than economic - the fear of being different and the fear of failure in the eyes of the rest of the community.

*159 829 (v) In spite of (possibly because of) experience in check-weighing, is no more prepared to trust M.M.U. and official marketing agencies than any other farmer.

CASE XIII : Toni (A part-time arable farmer and caretaker of a military camp.)

*159 241 434 An example of part-time farming in which the field operations are the subsidiary part of the business - from the financial point of view though not as regards the amount of time spent on them.

His caretaking duties bring him some £5 per week for most of the year and yet leave him with enough free time to cultivate several irrigable patches near the camp. Now aged nearly seventy he works a much smaller total area than the thirty tmien of his younger days. He could in fact live on his income from his caretaking and continues to work the fields for four reasons:

(a) To provide food for his present family of three,
(b) To produce a supplementary income from the sale of cash crops,
(c) To occupy his time with the farming which he knows - as something of a hobby,
(d) To provide his emigrated sons each "with a piece of land" when they return to Malta for their retirement.

241 198 46 *[159] Items (b) and (c) reflect his independence of farming for the maintenance of himself and his wife and daughter, while (c) and (d) suggest that although farming ceases to be the countryman's livlihood he inclines to retain a residual interest in it even when he has been away from Malta for the greater part of his working life. This is a characteristic [369] feature of rural Malta and an important aspect of the recent increase in part-time farming. The 1957 Census of Agri- [162] culture lists 9,588 part-time as against 7,813 full-time farmers (B/164, p.20). The trend towards part- in place of full-time farming is significant in the present overall retreat from agriculture. It represents in many cases a